WASHINGTON, D. C. 20024

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SUBJECT: TSAP - A Target Site Analysis Program - Case 610

DATE: September 30, 1969

FROM: D. P. Nash

ABSTRACT



TSAP analyzes and graphically prints data calculated by target-site visibility runs of the BCMASP Earth Orbit Simulator. The program is helpful in giving an immediate impression of the density of target contacts in each orbit of a mission and of the duration of such contacts. A useful application of this information is in photographic and communications analyses.

(NASA-CR-106864) TSAP - A TARGET SITE ANALYSIS PROGRAM CASE 610 (Bellcomm, Inc.) 19 p N79-71627

Unclas 00/12 11646 SUBJECT: TSAP - A Target Site Analysis Program - Case 610 DATE: September 30, 1969

FROM: D. P. Nash

MEMORANDUM FOR FILE

I. <u>Introduction</u>

TSAP has been developed to graphically display targetsite visibility data generated by the BCMASP Earth-Orbit Simulator.* It has the capability to display graphically the duration of contact between an orbiting craft and each of a set of ground targets during each orbit of a mission. This information makes readily apparent which sites are contacted most frequently and which orbits provide maximum contact opportunities. It is, therefore, particularly useful in analyses of communications coverage and of opportunities for photography of ground targets. For these purposes the program contains an option which permits the plotting of both individual and overlapping contacts greater than a threshold duration specified by the user. Such information can be used in determining optimum times for television transmissions, or for extended photographic coverage of successive sites.

II. Output

The output of TSAP consists of a printer-plotted graph preceded by three printed tables (Appendix A):

- a. Table 1 contains the names and locations of the sites.
- b. Table 2 contains an explanation of graph nomenclature.
- c. Table 3 contains input data from the Earth-Orbit Simulator run including date and time of launch, orbit definition, and criteria for target contact.

Figure 1 shows a graphical output from a TSAP communications run. Each orbit is indicated, and the name of each target contacted is identified by a three-letter acronym. A "D" or "E" printed beside the acronym indicates that the current local time

^{*}A. B. Baker, "Revisions to the BCMASP Earth-Orbit Simulator Program," Bellcomm Memorandum for File, In Preparation.

at the contact site is day (6 a.m. - 6 p.m.) or evening (6 p.m. - midnight). A star, "*", implies that the current contact overlaps the immediately preceding one. Acronyms REC and RTT printed before the target designation are available to indicate MSFN ground station capabilities to record telemetered information (REC) or to both record and transmit such information to MSC in real time (RTT).

The ordinate of the graph is printed horizontally across the page and is scaled from zero to ten minutes. The abscissa is scaled by orbit number, with target contacts shown in the order in which they occur during the mission. Capability exists to print a maximum of three lines parallel to the abscissa as references for contact durations of interest to the user. Their locations are specified in the input.

III. Input

Individual target contacts are read from a tape generated by the BCMASP Earth-Orbit Simulator. The values of several other variables must be provided by the user. These variables are contained in a NAMELIST called INPUT and include:

IPCOM	Set IPCOM=0 for photographic analysis. Set IPCOM=1 for communications analysis.
IPLOT	Set IPLOT=0 to plot every contact. Set IPLOT=1 to plot only those contacts greater than, or equal to, value of OVRLAY.
JJ	Set JJ equal to the total number of target contact records on tape. If the total number is unknown, set JJ=0.

RECORD* Set RECORD equal to the minimum threshold time (in minutes) for recording of telemetered data.

REALT* Set REALT equal to the minimum threshold time (in minutes) for transmission of a given class of telemetered information to MSC in real time.

^{*}The values of RECORD and REALT are meaningless in a photographic analysis and may be omitted from the data deck in a run of that type.

OVRLAY

This variable provides a reference line on the graph. When IPLOT=1, only individual and overlapping contacts greater than, or equal to, the value of OVRLAY will be plotted.

If contacts with MSFN ground stations are to be plotted, the user must also include for each station, I, a data card giving target name (MNAME(I,K), K=1,6 where K allows for 18 characters in the name), record capability (MREC(I)) and real time transmission capability (MRTT(I)). A value of 1 for MREC(I) or for MRTT(I) indicates an existence of the respective capability at the site. A value of zero indicates neither a recording nor a real time transmission capability.

Appendix B shows the format of a sample data deck for a photographic run. Appendix C contains corresponding information for a communications run. All other data required by the TSAP program is read from the tape generated by the BCMASP Earth-Orbit Simulator.

IV. Structure

An outline of the structure of TSAP is shown in the flow diagram of Figure 2. Appendix D contains a dictionary of the FORTRAN variables used in the program.

TSAP begins with an initialization section which prints the tables of input data and sets up the ordinate of the graph. A detailed diagram of this section is shown in Figure 3. Initially, input data from data cards and from the data tape are read. If JJ=0 (i.e., if the total number of contact records on tape is unknown to the user), the records are counted, the total is printed, and the tape is repositioned at the first contact record.* If a communications analysis is being executed, the program also reads the cards containing "recording" and "real time transmission" flags for each target site. Finally all of the input data is printed in tables.

^{*}The statement used by TSAP to count the total number of records is

READ(4,2000,END=4,ERR=4).

The END and ERR conditions exits, although operational under EXEC 2, have not yet been implemented under EXEC 8. The time estimate for implementation is one to six months. Therefore, it is temporarily necessary for the user to input the value of JJ.

Before the graph is constructed, subroutine FPMARG* is called. This routine insures a connected graph rather than one divided by upper and lower margins on each page of printout. Next, the scale unit of the ordinate is identified, and the scale factors are printed. The ordinate is constructed by filling elements 1 through 101 of array LINE with dots and printing the array across the page.

The reading and plotting of the target site contact information is executed within a large iteration loop shown in Figure 2. Figure 4 contains a detailed diagram of a smaller loop within the outside large loop structure. The initial action in the outside loop is the reading of a target site contact record which contains the following variables:

ORBIT The orbit number during which contact occurs.

MTARG The target site identification number.

ENTER The GET (Ground Elapsed Time) in seconds at which the site enters the field of view.

EXIT The GET in seconds at which the site leaves the field of view.

CONTAC The duration in minutes of contact with the site.

CURLT The current local time at the site at the midpoint of contact.

If only individual and overlapping contacts greater than or equal to OVRLAY are being plotted (i.e., IPLOT=1), a check is made to determine if the present record is part of a preceding series of overlapping contacts. If it is not, NUMCSC, the variable which indicates the number of consecutive records to be plotted, is set equal to one, and the values of the variables in the contact record are entered into temporary storage. The total continuous contact time (TOCON) is set equal to CONTAC, and another record is read. This process continues with NUMCSC increasing by one and TOCON increasing by the contact time with each site minus the overlap time until a contact does not overlap with a previous one. At this point a check is made to determine if TOCON is greater than,

^{*}FPMARG was developed for the EXEC 8 system by O. R. Pardo.

or equal to, OVRLAY. If it is, the data in temporary storage is plotted and the temporary registers are emptied. If it is not, the temporary storage is emptied immediately, and the next record is read.

The procedure followed when every contact is graphed is similar to that described above. When a record is read, NUMCSC is set equal to one, the record is entered into temporary storage, and TOCON is given the value of CONTAC. The data in storage is plotted, following which the temporary registers are emptied and another iteration is begun.

Before each contact is plotted, arrays LINE and ISYMB are filled with blanks. (ISYMB contains the characters indicating contact overlap and current local time of day at the contacted site.) A check is made on the orbit number of the contact; if it is different from that of the previous contact, the number is written beside the graph.

The length of the line representing contact time with a site is determined by the equation

NOW = TEMCON(NUM)*10.0 +1.5

where TEMCON(NUM) is the contact time in temporary storage. The variable INOW is set equal to NOW unless NOW exceeds the range of the ordinate. In the latter case INOW is set equal to 101, and an "X" is printed above the plotted line to indicate the discrepancy. Array LINE is filled with dots in elements one through INOW, "I"'s in the positions of the reference lines, and blanks in the remaining elements. A check is made for overlapping coverage and day or evening contact, after which the proper symbols are put into array ISYMB. Finally, all of the information for the contact is graphed. (In a communications analysis, the recording and real time transmission capabilities are also printed, where they exist.) Comparison variables are reset and the plotting process is repeated for each record in the temporary registers. When the final record in the temporary registers has been plotted, the total continuous contact time is printed if IPLOT=1. Otherwise, the program proceeds immediately to the next steps of emptying the temporary registers and then returning to read another record. The ordinate is redrawn after the final record on the tape has been plotted.

V. Future Extensions

With minor modifications to TSAP, additional information may be readily compiled from data available in the program, e.g., total number of contacts with each target site and total number of contacts per orbit.

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Attachments

APPENDIX A

OUTPUT TABLES

Table 1: Names and Locations of Target Sites

Site Number	Site	Latitude (degrees)	Longitude (degrees)
1	HAW-HAWAII	21.983	-159.677
2	GDS-GOLDSTONE	35.152	- 116.833
3	GYM-MEXICO	27.791	-110.716
4	TEX-TEXAS	27.492	-97.367
5	MIL-MERRIT ISLAND	28.187	-80.697
6	GBM-GRAND BAHAMAS	26.496	- 78.150
7	BDA-BERMUDA	32.176	-64.650
8	ANG-ANTIGUA	16.910	- 61.735
9	CYI-CANARY	27.577	-15.600
10	ACN-ASCENSION	-7.897	-14.316
11	MAD-MADRID	40.260	-4.167
12	CRO-CARN. AUS	-24.753	113.716
13	GWM-GUAM	13.214	144.733
14	HSK-CAN. AUS	-35.402	148.967

Table 2: Graph Nomenclature

*	INDICATES OVERLAPPING CONTACT WITH ADJACENT STATIONS
D	CONTACT ESTABLISHED BETWEEN 6 AM - 6 PM LOCAL TIME
E	CONTACT ESTABLISHED BETWEEN 6 PM - MIDNIGHT LOCAL TIME
RTT	REAL TIME TV TRANSMISSION
REC	TV RECORD CAPABILITY

TABLE 3: SAMPLE INPUT DATA

12.00000 HRS. 184.88598 N.MI.		212.00000 N.MI.
TIME OF LAUNCH GEOCENTRIC PERIGEE ALTITUDE		ALTITUDE OF ORBIT TRANSFER
SEP. 1, 1971 35.00496 DEG.	2 DAYS 9.78 HRS.	3 DAYS 8.17 HRS.
DATE OF LAUNCH ORBITAL INCLINATION NUMBER OF TARGETS	TIME OF DOCKING	APPROXIMATE TIME OF ORBIT TRANSFER

APPENDIX B

SAMPLE DATA DECK FOR A PHOTOGRAPHIC ANALYSIS RUN

- 1. Conditions for the run
 - A. Plot every contact.
 - B. Let the nominal time for photographic coverage of a site equal 1.5 minutes.
 - C. Assume the number of contact records on tape unknown.
- 2. Data Deck (Punch of data should begin in Column 2)

\$INPUT IPCOM=2, IPLOT=0, JJ=0, OVRLAY=1.5, \$END

APPENDIX C

SAMPLE DATA DECK FOR COMMUNICATIONS ANALYSIS RUN

- 1. Conditions for the run
 - A. Plot only individual and overlapping contacts greater than, or equal to, OVRLAY.
 - B. Assume the total number of contact records equals 500.
 - C. Minimum acceptable contact duration for recording TM (RECORD) equals 2 minutes.
 - D. Minimum acceptable time for real time TV transmission to MSC (REALT) equals 5 minutes.
 - E. Let OVRLAY equal REALT.
- 2. Data Deck (Punch of data should begin in designated columns)

(Column 2)

\$INPUT IPCOM=1, IPLOT=1, JJ=500, RECORD=2.0, REALT=5.0, OVRLAY=5.0, \$END

(Column	1)	(Column 21)	(Column 24)
	HAW-HAWAII GDS-GOLDSTONE GYM-MEXICO	1 1 1	1 1 1
	CRO-CARN, AUS	1	1

APPENDIX D

DICTIONARY OF TSAP FORTRAN VARIABLES

ALTO nm Geocentric perigee altitude. ALTI nm Final altitude of orbit transfer. APOALT nm Geocentric apogee altitude. CIRHRS hrs Number of elapsed hours into MDAYS at time of orbit circularization. CONTAC sec Duration of contact between spacecraft and a target during one pass. CURLT sec Current local time at target at midpoint of spacecraft contact DOKHRS hrs Number of elapsed hours into LDAYS at time of docking. ENTER sec GET at instant of acquiring contact. EXIT sec GET at instant of losing contact. EXLAST sec Exit time of previous contact. GINCL deg Orbital inclination. IBLANK Symbol used for plotting. IDAY days Day of launch of first vehicle. IDOT Symbol used for plotting. ILEVL Symbol used for plotting. INOW Variable which indicates contact time on the graph. INOW is set to 101 if contact time exceeds ordinate range. IPCOM Flag which indicates whether photographic analysis (IPCOM=0) or communications analysis (IPCOM=1) is being plotted.				
ALT1 nm Final altitude of orbit transfer. APOALT nm Geocentric apogee altitude. CIRHRS hrs Number of elapsed hours into MDAYS at time of orbit circularization. CONTAC sec Duration of contact between spacecraft and a target during one pass. CURLT sec Current local time at target at midpoint of spacecraft contact DOKHRS hrs Number of elapsed hours into LDAYS at time of docking. ENTER sec GET at instant of acquiring contact. EXIT sec GET at instant of losing contact. EXIAST sec Exit time of previous contact. GINCL deg Orbital inclination. IBLANK Symbol used for plotting. IDAY days Day of launch of first vehicle. IDOT Symbol used for plotting. ILEVL Symbol used for plotting. INOW Variable which indicates contact time on the graph. INOW is set to 101 if contact time exceeds ordinate range. IPCOM Flag which indicates whether photographic analysis (IPCOM=0) or communications analysis (IPCOM=1) is		Variable	Units	Description
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CONTAC sec Duration of contact between spacecraft and a target during one pass. CURLT sec Current local time at target at midpoint of spacecraft contact DOKHRS hrs Number of elapsed hours into LDAYS at time of docking. ENTER sec GET at instant of acquiring contact. EXIT sec GET at instant of losing contact. EXLAST sec Exit time of previous contact. GINCL deg Orbital inclination. IBLANK Symbol used for plotting. IDAY days Day of launch of first vehicle. IDOT Symbol used for plotting. ILEVL Symbol used for plotting. ILEVL Symbol used for plotting. INOW Variable which indicates contact time on the graph. INOW is set to 101 if contact time exceeds ordinate range. IPCOM Flag which indicates whether photographic analysis (IPCOM=0) or communications analysis (IPCOM=1) is		APOALT	nm	Geocentric apogee altitude.
CURLT sec Current local time at target at midpoint of spacecraft contact DOKHRS hrs Number of elapsed hours into LDAYS at time of docking. ENTER sec GET at instant of acquiring contact. EXIT sec GET at instant of losing contact. EXLAST sec Exit time of previous contact. GINCL deg Orbital inclination. IBLANK Symbol used for plotting. IDAY days Day of launch of first vehicle. IDOT Symbol used for plotting. ILEVL Symbol used for plotting. ILEVL Symbol used for plotting. INOW Variable which indicates contact time on the graph. INOW is set to 101 if contact time exceeds ordinate range. IPCOM Flag which indicates whether photographic analysis (IPCOM=0) or communications analysis (IPCOM=1) is		CIRHRS	hrs	
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(IPCOM=0) or communications analysis (IPCOM=1) is		INOW		INOW is set to 101 if contact time exceeds ordi-
		IPCOM		(IPCOM=0) or communications analysis (IPCOM=1) is

Appendix D (Continued)

- 2 -

Variable	Units	Description
IPLOT		Flag which indicates whether every contact (IPLOT=0) or only individual and overlapping contacts greater than OVRLAY (IPLOT=1) are to be plotted.
<pre>ISCALE(I)</pre>		Array containing ordinate scale identification.
ISIGNL		Location of marker to indicate contact in excess of ordinate range.
ISTAR		Symbol used for plotting.
ISYMB(I)		Array containing symbols used to identify current local time of contact and contact overlap.
IYEAR		Year of launch.
KUMTAC		Plotting position of reference line indicated by user.
LAST		Location of the last contact time plotted.
LDAYS	days	Integral number of elapsed days from lift-off to docking.
LINE(I)		The array containing the characters used for plotting.
LSTORB		Orbit of immediately preceding contact plotted.
LSTREC		Recording capability of previous contact.
LSTRTT		Real time transmission capability of previous contact.
LTDOCK	sec	Integral GET at docking.
MCIRC	sec	Integral GET at circularization.
MDAYS	days	Integral days from lift-off to circularization.
MNAME		Name of target site. FORMAT 6A3. The first 4 characters must consist of a 3-letter acronym followed by a dash.
MREC(I)		Flag indicating record capability of target site I.

Appendix D (Continued) - 3 -

Variable	Units	Description
MRTT(I)		Flag indicating real time transmission capability of target site I.
MTARG		Reference number designating a target site.
MTEMOR		Temporary register for storage of orbit number.
MTEMTG		Temporary register for storage of target number.
NAME		Target name read from data tape.
NOW .		Variable which indicates length of contact line on graph.
NUMCSC		Number of records in temporary storage.
ORBIT		Orbit number.
OVRLAY	min	Ordinate of reference line located by user.
PREX	sec	Exit time of preceding contact from field of view.
QANGLE	deg	Maximum viewing angle.
QMONTH	mth	Month of launch.
REALT	min	Threshold time for recording of telemetered data at an MSFN ground station.
RECORD	min	Threshold time for both recording and real time transmission of telemetered data to MSC.
TCIRC	sec	GET at circularization of orbit.
TDOCK	sec	GET at docking.
TEMCLT	hrs	Temporary register for storage of current local time.
TEMCON	min	Temporary register for storage of total contact time with site.
TEMENT	sec	Temporary register for storage of time of target site entry into viewing circle.
TEMEXT	sec	Temporary register for storage of time of target site exit from viewing circle.

Appendix D (Continued)

- 4 -

Variable	Units	Description
TIMELO	hrs	Time of launch.
TOCON	min	Total time of continuous contact.
TPLAT(I)	deg	Latitude of target site I.
TPLON(I)	deg	Longitude of target site I.

FIGURE 1: SAMPLE OUTPUT FROM TSAP

CONTACT TIME IN MINUTES

	Z	Z	Z I				Z E	Z I	Z	Z Z				E Z	1		
• • •	7.750	6.750	60 				17.378	7.500	6.625	6.250				5.750			
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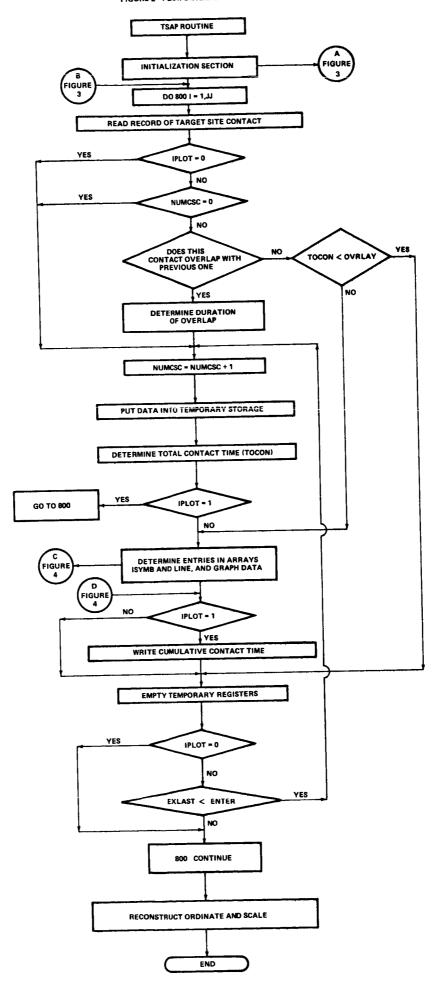


FIGURE 3-TSAP INITIALIZATION SECTION

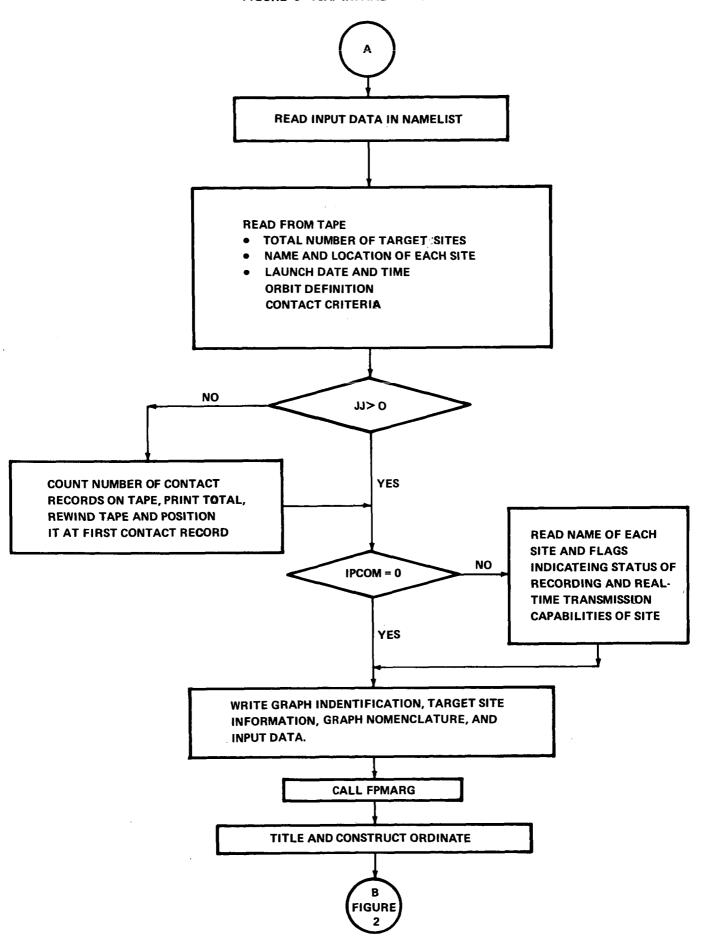
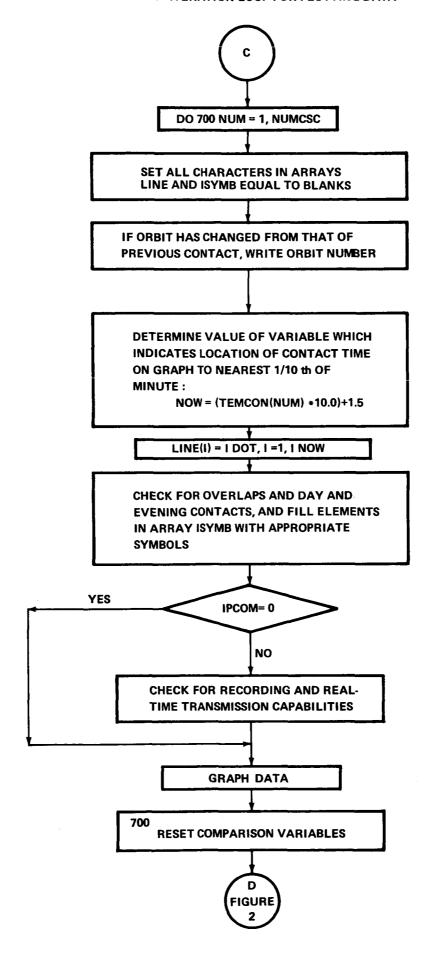


FIGURE 4 - ITERATION LOOP FOR PLOTTING DATA



Subject: TSAP - A Target Site Analysis

Program - Case 610

From: D. P. Nash

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